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A Collective Model for Female Labour Supply with Nonparticipation and Taxation

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DISCUSSION
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A collective model for female labour supply with nonparticipation and taxation

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Abstract

In this paper, a collective discrete choice model is presented for female labour supply. Both preferences of females and the intrahousehold allocation process are econometrically identified. The model incorporates nonparticipation and nonlinear taxation. It is applied to Belgian microdata and is used to evaluate the 2001 Tax Reform Act. We find moderate negative behavioural responses to the reform. The tax reform further implies a Pareto improvement for most of the households in the sample.

Key words: collective household models, intrahousehold allocation, labour supply, tax reform, identification.

JEL classification: D11, D12, J22.

1 Introduction

Usually, evaluations of the impact of tax reforms on employment and hours of work are cast in the unitary framework. In this framework, it is assumed that households, even if they consist of several individuals, behave as if they were single decision making units. Recent examples of such tax reform evaluations are Hoynes (1996) and Blundell et alii (1999). One important deficiency of the unitary approach from a welfare economic point of view is that it is not able to say anything on the intrahousehold allocation of welfare. Apps and Rees (1988) and Brett (1998) have shown, however, that intrahousehold distributional issues can in general not be ignored in normative welfare analyses. Another shortcoming of the approach is that its theoretical implications seem to be overly restrictive. As a consequence, they were repeatedly rejected when confronted with household labour supply data (see Fortin and Lacroix, 1997 for some recent evidence).

A valuable alternative to the unitary approach is the collective approach to household behaviour. This approach, which was introduced by Chiappori (1988,

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1992) and Apps and Rees (1988), takes account of the fact that multi-person households consist of several individuals who have their own preferences. It is assumed that these individuals are involved in an intrahousehold bargaining process that results in Pareto efficient intrahousehold allocations. The collective approach implies other behavioural restrictions than the unitary model (see, e.g., Chiappori, 1988, 1992 and Browning and Chiappori, 1998). Contrary to the unitary model's restrictions, these testable implications of the collective model turn out to be less restrictive (see references in Vermeulen, 2002a). Moreover, the specific setting of the collective model allows to analyse the intrahousehold welfare distribution under some additional assumptions (see Chiappori, 1988, 1992). Clear evidence of conflicting outcomes of the unitary and collective approach with respect to welfare evaluations of tax reforms is given in the different contributions of Laisney (2002).

Gradually, many topics in the labour supply literature are translated into a collective setting. Chiappori (1988, 1992) and Chiappori, Fortin and Lacroix (2002) derive collective restrictions and identification results with respect to individual preferences and the intrahousehold allocation process. These studies do not take into account taxation and nonparticipation. In Blundell et alii (2001), testable implications and identification results are derived for a collective labour supply model that allows for both nonparticipation and unobserved preference heterogeneity. Nonparticipation and nonlinear taxation are dealt with in Donni (2001). Under some additional assumptions, identification of a great deal of individual preferences and the intrahousehold allocation process is possible. The model, without nonparticipation, has been applied in Moreau and Donni (2002).

To the best of our knowledge, the only empirical studies that tackle both nonparticipation and nonlinear taxation are the contributions in Laisney (2002). In these studies, household labour supply is modelled as a discrete choice problem. In other words, individuals are assumed to have the choice between a discrete set of labour supply options. This approach, which is rather popular nowadays, allows to incorporate very general nonlinear and nonconvex tax schemes (see, van Soest, 1995, Bingley and Walker, 1997, Keane and Moffitt, 1998, Blundell et alii, 1999 and Gong and van Soest, 2002, for some examples). In Laisney (2002), individual preferences and the intrahousehold allocation process are identified, in a piecemeal way, by means of both econometric estimation and calibration techniques.

The aim of this paper is to present a collective and *econometrically identifiable* discrete choice model for female labour supply. The model is fairly general in that it incorporates both nonparticipation and nonlinear taxation. The focus on female choice behaviour is driven by the empirical observation that almost all men in the sample we are using work full time. Their contractual working hours typically reflect the number of hours that are worked in many economic sectors. The intrahousehold allocation process and the preferences of women in couples are *completely* identified by assuming that their preferences are egoistic and to some extent identical to those of single women. Egoistic preferences are more restrictive than those assumed in Laisney (2002). In the latter study, externalities within a household with respect to labour supply were allowed at the cost of a piecemeal identification procedure. Alternatively, our assumption is less restrictive than the assumption of equal preferences between singles and individuals in couples that was made in Barmby and Smith (2001) to obtain

complete identification. Moreover, their model does not take into account nonlinear taxation and nonparticipation issues.

It will be shown that the model presented here allows for richer behavioural implications than the unitary model. In addition, it is able to say something on who gets what in the household. Consequently, normative welfare analyses can be done at the individual level, rather than at the household level. The model is applied to Belgian microdata. The sample selection is for childless individuals that are working or voluntarily unemployed. Students, self-employed, involuntarily unemployed and retired people are excluded from the dataset. The model will be used as a basis for an evaluation of the impact on employment, hours and individual consumption of the Belgian 2001 Tax Reform Act. This reform is to be implemented between the years 2001 and 2004 and implies some important changes with respect to the current tax system.

The remainder of the paper is organized as follows. Section 2 presents the economic model that is cast in a collective framework. In Section 3 a short description of the current Belgian tax system is given. It also covers the main features of the 2001 Tax Reform Act. Section 4 discusses the data and presents model estimates. Tax reform simulation results are given in Section 5. Section 6 concludes.

2 The economic model

2.1 A sharing rule interpretation

We consider households that consist of two working age individuals (m and f) and female singles. Labour supply of single men and of men in couples is assumed to be fixed at full time working hours. Empirical evidence for this assumption is given in Section 4. Note that the assumption is also supported by Pencavel (1986) who concludes that male labour supply is rather insensitive to changes in economic variables like wages and nonlabour income. We further assume that preferences of individuals in couples are egoistic (see Chiappori, 1988). In other words, utility is derived only from own consumption and leisure.

Preferences of females are represented by the following well-behaved direct utility function:

$$u^f = v^f\left(c^f, l^f, \mathbf{d}^f\right), \tag{1}$$

where c^f denotes the female's private consumption of a Hicksian aggregate commodity, l^f is leisure and $\mathbf{d}^f$ is a vector of demographic characteristics (e.g., a variable indicating whether the female is single or living in a couple, age and education level). Budget constraints for female singles and couples are respectively equal to:

$$c^f \leq y + w^f \ell^f - \tau^f\left(w^f \ell^f, y, \mathbf{d}^f\right) \tag{2}$$

and

$$c^m + c^f \leq y + w^m \ell^m + w^f \ell^f - \tau^c\left(w^m \ell^m, w^f \ell^f, y, \mathbf{d}^m, \mathbf{d}^f\right) = x, \tag{3}$$

where w^i is individual i's gross hourly wage rate, ℓ^i is individual i's labour supply ($\ell^i = T - l^i$, where T is total time available), c^m is the male's private

consumption, y is nonlabour or other income and τ^f and τ^c are tax functions that capture the income tax that in general depends on earned incomes, other income and demographic characteristics. Let us denote total household means by x.

The core assumption in the collective approach is that individuals in couples choose Pareto efficient allocations (see Chiappori, 1988, 1992). It is a well-known result that if preferences are of the egoistic type, then any Pareto efficient allocation can be represented as a two stage budgeting process, where household members first divide total household consumption among themselves. In a second step, each individual maximizes her or his own utility subject to an individual budget constraint. In our setting with fixed male labour supply, this amounts to the following maximization problem:

$$\max_{c^f, l^f} v^f \left(c^f, l^f, \mathbf{d}^f\right) \tag{4}$$

subject to

$$c^f \leq \phi\left(x, \mathbf{z}\right),$$

where ϕ is a function that determines the part of total household consumption x that is transferred to the woman in the couple. Following Chiappori (1988), let us call ϕ the *sharing rule*.[1] In general this sharing rule will depend on a number of variables $\mathbf{z}$ that influence an individual's bargaining power in the household. In Chiappori (1988, 1992), individual wages and other income act as such variables. However, in a setting with nonlinear income taxation these variables seem to be less adequate. In the empirical exercise we will make use of a variable that already proved useful in the different contributions in Laisney (2002). It captures the *earning capacity* of the female in the household. The variable is defined as the difference between total household consumption when the female works full time and total household consumption when she does not participate in the labour market. This variable thus incorporates elements related to her productivity and elements related to the nonlinear tax system.[2]

How can we now identify both preferences of females, as represented by v^f, and the sharing rule, as represented by ϕ, in an efficient way? Note that in labour supply datasets, only *total* household consumption (net income) is observed, and not the private consumption levels c^m and c^f. This rules out a direct estimation of females' preferences by means of the variables c^f and ℓ^f, via a discrete choice model for instance.

One possibility to identify preferences and the sharing rule is to make use of observed labour supply behaviour of single women, in addition to couples' behaviour. Note that preferences of singles can easily be identified by means of standard techniques, since the unitary approach is fully applicable to them. In Barmby and Smith (2001), for example, preferences of individuals in couples

[1] Note that this representation of the sharing rule slightly differs from that in Donni (2001). He makes use of virtual wages and nonlabour incomes which are a direct translation of the sharing rule in collective labour supply models without taxation (see Chiappori, 1988, 1992). Our representation will turn out to be very convenient in a discrete choice setting (cf. infra).

[2] Note that this variable also depends on the male's productivity. It is for example easily seen that, ceteris paribus, a female's earning capacity decreases if her husband's gross income increases in a joint tax system with progressive marginal rates.

are identified by assuming that their preferences equal those of singles. As will be shown below, we do not have to go that far to identify both preferences and the sharing rule. However, our assumption to obtain complete identification is more restrictive than the approach followed by Chiappori (1988, 1992) and Donni (2001). The latter studies only make use of information in a couples dataset to identify the sharing rule up to an additive constant and preferences up to a translation.

2.2 Empirical specification of the model

We opt for a discrete choice model for female labour supply. This approach, which was introduced by van Soest (1995), assumes that individuals can choose between a limited number of labour supply options. The specific setting allows to incorporate very general (e.g., nonlinear and noncontinuous) tax schemes. The optimization problem consists of comparing the different utility levels associated with each of the available hours choices and choosing that one which yields the highest utility.

Let us assume that females have J labour supply choices, each choice associated with a particular consumption level. Preferences of women are assumed to be representable by a restricted version of the quadratic direct utility function (see Stern, 1986). The utility that woman i derives from labour supply choice j is given by:

$$\begin{aligned} u_{ij}^f &= v^f\left(c_{ij}^f, l_{ij}^f, \mathbf{d}_i^f\right) + \varepsilon_{ij} \\ &= \beta_{\ell\ell}\left(\mathbf{d}_i^f\right)\cdot\left(\ell_{ij}^f\right)^2 + \beta_{c\ell}\cdot\ell_{ij}^f c_{ij}^f + \beta_c\cdot c_{ij}^f + \beta_\ell\left(\mathbf{d}_i^f\right)\cdot\ell_{ij}^f + \varepsilon_{ij}, \end{aligned} \tag{5}$$

where $\ell_{ij}^f = T - l_{ij}^f$ and ε_{ij} is an unobserved preference component that is assumed to be distributed as a type I extreme value random variable. The preference parameters $\beta_{\ell\ell}\left(\mathbf{d}_i^f\right)$ and $\beta_\ell\left(\mathbf{d}_i^f\right)$ are assumed to be heterogeneous across individuals (among others, across single females and women in couples) and are of the following form:

$$\beta_{\ell\ell}\left(\mathbf{d}_i^f\right) = \beta_{\ell\ell 0} + \boldsymbol{\beta}'_{\ell\ell 1}\mathbf{d}_i^f + \upsilon_{\ell\ell i} \tag{6}$$

and

$$\beta_\ell\left(\mathbf{d}_i^f\right) = \beta_{\ell 0} + \boldsymbol{\beta}'_{\ell 1}\mathbf{d}_i^f + \upsilon_{\ell i}. \tag{7}$$

Following Train (1998), an extra source of unobserved preference heterogeneity across individuals is introduced via the disturbances $\upsilon_{\ell\ell i}$ and $\upsilon_{\ell i}$. These are assumed to be mean zero normally distributed: $\upsilon_{\ell\ell i} \backsim N\left(0, \sigma^2_{\upsilon_{\ell\ell}}\right)$ and $\upsilon_{\ell i} \backsim N\left(0, \sigma^2_{\upsilon_\ell}\right)$.

As has been demonstrated by McFadden (1974), if the disturbances ε_{ij} are independent and identically distributed with type I extreme value distribution, then the probability that individual i opts for labour supply choice k, given

disturbances $\upsilon_{\ell\ell i}$ and $\upsilon_{\ell i}$, equals:

$$\begin{aligned}\Pr\left(z_i = k; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right) &= \Pr\left(u_{ik}^f > u_{ij}^f, \forall j \neq k; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right) \\ &= \frac{\exp\left(v^f\left(c_{ik}^f, l_{ik}^f, \mathbf{d}_i^f; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right)\right)}{\sum_{j=1}^J \exp\left(v^f\left(c_{ij}^f, l_{ij}^f, \mathbf{d}_i^f; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right)\right)},\end{aligned} \tag{8}$$

where z_i is a random variable which indicates the choice made. The corresponding unconditional probability equals:

$$\begin{aligned}\Pr\left(z_i = k\right) &= \Pr\left(u_{ik}^f > u_{ij}^f, \forall j \neq k\right) \\ &= \int\int \frac{\exp\left(v^f\left(c_{ik}^f, l_{ik}^f, \mathbf{d}_i^f; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right)\right)}{\sum_{j=1}^J \exp\left(v^f\left(c_{ij}^f, l_{ij}^f, \mathbf{d}_i^f; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right)\right)} f\left(\upsilon_{\ell\ell i}\right) f(\upsilon_{\ell i})\, d\upsilon_{\ell\ell i} d\upsilon_{\ell i}.\end{aligned} \tag{9}$$

The likelihood function of this random parameters logit model equals:

$$\log L =$$

$$\sum_{i=1}^n \sum_{j=1}^J d_{ij} \log \int\int \frac{\exp\left(v^f\left(c_{ij}^f, l_{ij}^f, \mathbf{d}_i^f; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right)\right)}{\sum_{k=1}^J \exp\left(v^f\left(c_{ik}^f, l_{ik}^f, \mathbf{d}_i^f; \upsilon_{\ell\ell i}, \upsilon_{\ell i}\right)\right)} f\left(\upsilon_{\ell\ell i}\right) f(\upsilon_{\ell i})\, d\upsilon_{\ell\ell i} d\upsilon_{\ell i}, \tag{10}$$

where d_{ij} is a binary variable which equals 1 if individual i has opted for labour supply choice j and 0 otherwise. Estimates of the structural preference parameters and variances of unobserved preference components $\sigma^2_{\upsilon_{\ell\ell}}$ and $\sigma^2_{\upsilon_\ell}$ can be obtained by means of simulated maximum likelihood methods (see Train, 1998).

Necessary elements for the application of a discrete choice model are the individual consumption levels c_{ij}^f associated with the different labour supply choices. For female singles, these consumption levels are observed, given gross wage rates (observed for participants, estimated for nonparticipants; cf. infra), other income, individual characteristics and the tax system. As already mentioned, private consumption levels of women in couples are *not* observed. We know, however, that the female's private consumption at the j'th labour supply choice c_{ij}^f equals the share of total household consumption x_{ij} that is allocated to her by means of the sharing rule ϕ. Let us assume that this sharing rule is of the following form:

$$\phi\left(x_{ij}, z_i\right) = \left(1 + \kappa_1 + \kappa_2 z_i\right) \cdot x_{ij}, \tag{11}$$

where z_i is the female's earning capacity (cf. supra), and κ_1 and κ_2 are parameters that are to be estimated.[3] Note that $0 < 1 + \kappa_1 + \kappa_2 z_i < 1$. By

[3]Each variable that affects the bargaining power of the individuals in a household but does not affect preferences can be taken up in the sharing rule (such variables are usually called 'distribution factors'). See Browning and Chiappori (1998) and Chiappori, Fortin and Lacroix (2002) for some examples. It may be difficult, however, to find good distribution factors. Contrary to Chiappori, Fortin and Lacroix (2002), an index capturing divorce laws or laws on alimony cannot be used for Belgium, since all regions have the same legislation on divorce and alimony.

making use of a dummy variable s_i which indicates whether woman i is single ($s_i = 0$) or living in a couple ($s_i = 1$), we can define a budget constraint that is simultaneously applicable to both single women and women in couples:

$$c_{ij}^f = (1 + \kappa_1 s_i + \kappa_2 s_i z_i) \cdot x_{ij}. \tag{12}$$

Substituting equation (12) for c_{ij}^f in equation (5), we obtain the following 'collective' female utility function with observable regressors:

$$\begin{aligned} u_{ij}^f &= \beta_{\ell\ell}\left(\mathbf{d}_i^f\right) \cdot \left(\ell_{ij}^f\right)^2 + \beta_{c\ell} \cdot \ell_{ij}^f \cdot (1 + \kappa_1 s_i + \kappa_2 s_i z_i) \cdot x_{ij} \\ &\quad + \beta_c \cdot (1 + \kappa_1 s_i + \kappa_2 s_i z_i) \cdot x_{ij} + \beta_\ell\left(\mathbf{d}_i^f\right) \cdot \ell_{ij}^f + \varepsilon_{ij}. \end{aligned} \tag{13}$$

Application of this structural form in a random parameters logit model results in the direct identification of the parameters $\beta_{\ell\ell}\left(\mathbf{d}_i^f\right)$, $\beta_{c\ell}$, $\beta_{c\ell 1}^* = \beta_{c\ell}\kappa_1$, $\beta_{c\ell 2}^* = \beta_{c\ell}\kappa_2$, β_c, $\beta_{c1}^* = \beta_c\kappa_1$, $\beta_{c2}^* = \beta_c\kappa_2$ and $\beta_\ell\left(\mathbf{d}_i^f\right)$. By means of these estimates, we can derive the sharing rule parameters:

$$\kappa_1 = \frac{\beta_{c\ell 1}^*}{\beta_{c\ell}} = \frac{\beta_{c1}^*}{\beta_c} \tag{14}$$

and

$$\kappa_2 = \frac{\beta_{c\ell 2}^*}{\beta_{c\ell}} = \frac{\beta_{c2}^*}{\beta_c}. \tag{15}$$

Equations (14) and (15) imply two testable restrictions of this collective labour supply model. The underlying idea is that the female's private consumption can only change via the sharing rule that allocates total household consumption to both household members. Since the female's private consumption occurs twice in the given functional form, the sharing rule should twice have the same effect on female consumption. Note that these restrictions are implied by the specific functional form rather than by the collective approach as such.

It is also clear from equations (13), (14) and (15) that the equality of the preference parameters $\beta_{c\ell}$ and β_c for single women and females in couples is necessary and sufficient for the identification of both female preferences and the sharing rule. Without it, preferences and the sharing rule cannot be disentangled. Nevertheless, there is much room for preference variation between singles and women in couples with respect to the parameters $\beta_{\ell\ell}\left(\mathbf{d}_i^f\right)$ and $\beta_\ell\left(\mathbf{d}_i^f\right)$. Marginal rates of substitution between consumption and leisure may well differ, implying that the above assumption does not seem to be overly restrictive.

Apart from the above collective restrictions, the model implies the standard unitary restrictions on the female's utility function. These restrictions boil down to the utility function (5) being (strictly) quasi-concave, monotone increasing in consumption c^f and monotone decreasing in labour supply ℓ^f. This implies the following restrictions on the parameters for all $\left(c^f, \ell^f\right)$:

$\beta_{c\ell}\ell^f + \beta_c > 0$ (monotonicity restriction w.r.t. consumption)

$2\beta_{\ell\ell}\left(\mathbf{d}^f\right)\ell^f + \beta_{c\ell}c^f + \beta_\ell\left(\mathbf{d}^f\right) < 0$ (monotonicity restriction w.r.t. labour supply)

$\beta_{c\ell}\left[2\beta_{\ell\ell}\left(\mathbf{d}^f\right)\ell^f + \beta_{c\ell}c^f + \beta_\ell\left(\mathbf{d}^f\right)\right] - \beta_{\ell\ell}\left(\mathbf{d}^f\right)\left[\beta_{c\ell}\ell^f + \beta_c\right] > 0$ (quasi-concavity restriction).

Note that the last two restrictions depend on the unobserved disturbances coming from the assumed preference heterogeneity across individuals. One possibility is a test of these restrictions for the expected value of the parameters $\beta_{\ell\ell}\left(\mathbf{d}^f\right)$ and $\beta_\ell\left(\mathbf{d}^f\right)$.

3 The Belgian tax-benefit system and the 2001 Tax Reform Act

3.1 The Belgian tax-benefit system

In the empirical exercise, we will focus on a simplified tax-benefit system. Firstly, information on many items that affect the tax liability of households is lacking in the dataset that will be used. Examples of such items are contributions to private pension funds and capital redemptions due to mortgage loans. Secondly, given the selected sample for the empirical exercise, we can safely restrict attention to tax rules that are applicable to labour incomes and ignore rules on incomes coming from, e.g., pensions and unemployment benefits. Also child benefits do not have to be taken into account, since we focus on childless households. We will only sketch the tax system that is applicable to the selected sample. A more elaborate discussion of the Belgian tax-benefit system can be found in Vermeulen (2002b).

The simplified tax scheme for the year 2000 that is used for the sample of single women consists of four main components. These are (1) the social security tax that is to be paid by employees, (2) the standard deductions, (3) the marginal tax rate scheme and (4) the standard tax credits. The social security tax is equal to a constant rate of 13.07% which is applied to gross labour income. In a next step, standard expenses are deducted from labour income net of social security contributions at a decreasing marginal rate ranging from 20% on the first 4,165 euros to 3% on the bracket up to 55,470 euro. After these standard deductions, the marginal tax rate scheme is applied to taxable labour income. This marginal tax rate scheme consists of seven marginal tax rates, ranging from 25%, applied to the first 6,400 euros, to 55% for the taxable labour income above 61,230 euro. This operation results in the gross tax liability. Net tax liability is obtained by subtracting the appropriate tax credits. The first tax credit is that related to the basic exemption from income taxation. For a single, this exemption equals about 5,200 euro. If taxable labour income is higher than this exemption, a credit of about 1,300 euro is obtained. Next to this tax credit, there is the tax credit related to family size. Since the households in the selected sample are childless, this credit can be ignored in the empirical exercise. Finally, there is a negative tax credit related to the temporary crisis surcharge.[4] After application of the other tax credits, an extra tax rate of 3% is applied to the resulting tax liability.

The tax scheme for married couples differs from the above tax scheme in two respects. Firstly, married individuals can make use of the so-called 'marital

[4]The objective of this tax, which was introduced in 1993, was to generate extra means to meet the budget and debt criteria of the Maastricht Treaty.

quotient' if some conditions are satisfied. This tax rule allows to shift a part of the taxable labour income of one of the spouses to the other spouse. In our simplified tax scheme, couples are allowed to make use of this marital quotient if the taxable labour income of the spouse with the lowest earnings does not exceed 30% of the joint taxable labour income. The part that is shifted to the spouse with lowest earnings equals 30% of joint taxable labour income, minus the own taxable labour income of that spouse. It has a maximum of about 7,500 euro however. A second main difference between the tax scheme for singles and couples, is the basic exemption that is related to the tax credit. This exemption equals about 4,140 euro for each spouse.

3.2 The 2001 Tax Reform Act

In August 2001, the new Tax Reform Act was proclaimed. This reform is to be implemented over the period 2001 to 2004 and implies some relatively sweeping changes of the current tax system. According to the government, the cost of this reform is estimated at 3.25 billion euro or 10.7% of the amount generated in 2001 by the personal income tax system net of the temporary crisis surcharge (see Reynders, 2000). There are four main measures that are important for the selected sample in the empirical exercise.

The first important change in comparison to the current tax system, is the introduction of a refundable tax credit for the lowest labour incomes. A tax credit of about 620 euro will be given to individuals with a labour income (after deduction of social security contributions and deductions for professional expenses) between about 3,700 and 12,400 euro. Eligible working individuals that do not pay taxes or pay less taxes than this credit receive an extra income equal to the difference between the credit and the taxes paid. Individuals that participate in the labour market and earn less or more than the above boundaries may be eligible to a reduced tax credit. According to the government, the objectives of this in-work tax credit is to improve work incentives by making work pay and to better the income position of some working individuals.

A second feature of the tax reform is the broadening of the middle tax brackets and the lowering of the two highest marginal tax rates from 52.5% and 55% to 50%. This measure is introduced to decrease the fiscal pressure on respectively the middle and the highest incomes.

A third measure is that the tax exemption of married individuals and singles will be equalized. In the current system, the tax exemption of married individuals and, possibly cohabiting, singles differ. This exemption is to be brought at the higher singles' level.

Finally, the marital quotient will also be applicable to (unmarried) individuals with a cohabitation contract.

4 Data and empirical results

4.1 Data

The data is drawn from the 1992 and 1997 Socio-Economic Panel (SEP) of the Center for Social Policy (University of Antwerp). This panel is representative

for the Belgian population and is primarily used for research of poverty issues, the effectiveness of social security and the welfare distribution.

Two samples are selected for the empirical exercise. The first sample consists of female singles without children, aged between 25 and 55 inclusive and who are employed or voluntarily unemployed. Students, self-employed, unemployed and retired people are excluded from the dataset. The second sample consists of married or de-facto couples subject to the same sample selection as single females. To minimize the impact of measurement error, individuals with wages below or above the 1 and 99 percentiles of the wage distribution were also excluded. The sample sizes are respectively 128 and 340 for female singles and couples. Note that hourly gross wage rates are unobserved for individuals that do not participate in the labour market. These wages are estimated by means of Heckman's two step estimation procedure (see Vermeulen, 2002b for more detailed results).

In Tables 1 and 2 summary statistics on both selected samples are given. Histograms on average weekly contractual hours of singles and individuals in couples are given in Figures 1-4.[5] As is clear from Figures 2 and 4, labour supply of men is highly concentrated around 38 hours. Only a small fraction of men have a contractual labour supply that deviates from this mode. Moreover, there are no men who are not working for the selected sample. This fleshes out the assumption made earlier that all men work full time. Labour supply of women has a larger variance. Figures 1 and 3 clearly show that an important fraction of the females do not participate in the labour market. This fraction is higher for women in couples than for singles. A not unimportant fraction of the females is working part-time, with peaks around 20 and 30 hours.

In the empirical exercise, we will assume that women have the following discrete choice set: $\ell^f \in \{0, 20, 30, 38\}$.[6] For each of these weekly hours choices, the corresponding household net income (i.e., total household consumption) is calculated. This net income depends on the individuals' gross hourly wages, the household's nonlabour income and the tax system.

[5]The sample of single males is subject to the same sample selection rules as those for single females.

[6]Observed hours ℓ_0^f (see Figures 1 and 3) were allocated to the elements of the discrete choice set as follows: $\ell^f = 0$ if $\ell_0^f = 0$; $\ell^f = 20$ if $\ell_0^f \in]0, 25]$; $\ell^f = 30$ if $\ell_0^f \in]25, 35]$ and $\ell_0^f = 38$ if $\ell_0^f > 35$.

Table 1: Descriptive statistics single women (128 obs.)

Variable	Mean	Std.dev.
Dummy for labour market participation	0.94	0.24
Dummy 1 for schooling	0.43	0.50
Dummy 2 for schooling	0.32	0.47
Dummy 3 for schooling	0.16	0.36
Dummy 1 for region	0.30	0.46
Dummy 2 for region	0.19	0.39
Age	38.17	9.98
Number of years employed	15.10	9.59
Hourly gross wage rate	13.01	5.56
Contractual working hours per week	32.51	10.76
Weekly consumption based nonlabour income	57.92	55.07

Notes: Dummy for labour market participation: 1 = working. Dummy 1 for schooling: 1 = secondary school (primary school benchmark). Dummy 2 for schooling: 1 = non academic higher education. Dummy 3 for schooling: 1 = academic higher education. Dummy 1 for region: 1 = Walloon Region (Flemish Region benchmark). Dummy 2 for region: 1 = Brussels Capital Region. Monetary values are in euro.

Table 2: Descriptive statistics couples (340 obs.)

Variable	Mean	Std.dev.
Dummy for labour market participation wife	0.77	0.42
Dummy for labour market participation husband	1	0
Dummy 1 for schooling wife	0.54	0.50
Dummy 2 for schooling wife	0.25	0.44
Dummy 3 for schooling wife	0.06	0.24
Dummy 1 for schooling husband	0.57	0.50
Dummy 2 for schooling husband	0.24	0.43
Dummy 3 for schooling husband	0.08	0.28
Dummy 1 for region	0.24	0.43
Dummy 2 for region	0.04	0.21
Age wife	36.68	9.72
Age husband	38.63	9.70
Number of years employed wife	12.26	9.24
Number of years employed husband	18.47	10.89
Hourly gross wage rate wife	11.66	3.93
Hourly gross wage rate husband	14.65	5.88
Contractual working hours per week wife	26.76	15.94
Contractual working hours per week husband	37.99	2.06
Weekly consumption based nonlabour income	40.09	109.58

Notes: Dummy for labour market participation: 1 = working. Dummy 1 for schooling: 1 = secondary school (primary school benchmark). Dummy 2 for schooling: 1 = non academic higher education. Dummy 3 for schooling: 1 = academic higher education. Dummy 1 for region: 1 = Walloon Region (Flemish Region benchmark). Dummy 2 for region: 1 = Brussels Capital Region. Monetary values are in euro.

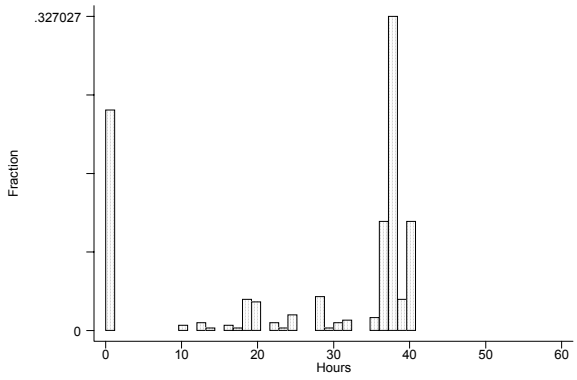

Figure 1: Contractual working hours per week for women in couples

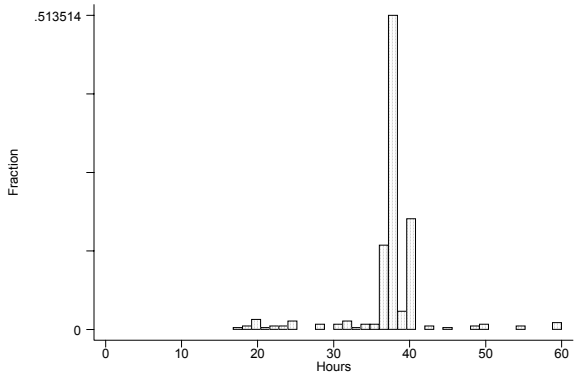

Figure 2: Contractual working hours per week for men in couples

4.2 Empirical results

The second column of Table 3 reports unrestricted estimates of the model for female labour supply (see equation (13)).[7] According to a likelihood ratio test, the conditional logit model (in other words, model without unobserved preference heterogeneity with respect to $\left(\ell^f\right)^2$ and ℓ^f) cannot be rejected. Twice the difference between the log likelihood of the restricted model and the log likelihood of the unrestricted model equals 0.15. This test statistic is to be compared to the critical value $\chi^2_{0.05}(2) = 5.99$.

Let us now turn attention to the explanatory variables that are specific to the collective approach. Two variables related to the sharing rule are significantly estimated at the 5% significance level. Important with respect to the above collective model, is that a Wald test cannot reject the restrictions (14) and (15). The test statistic equals 2.74 and is lower than the critical value $\chi^2_{0.05}(2) = 5.99$. The unitary monotonicity and quasi-concavity restrictions were tested by check-

[7]The number of randomly drawn values for $v_{\ell\ell i}$ and $v_{\ell i}$ in the simulated maximum likelihood method equals 100 (cf. supra).

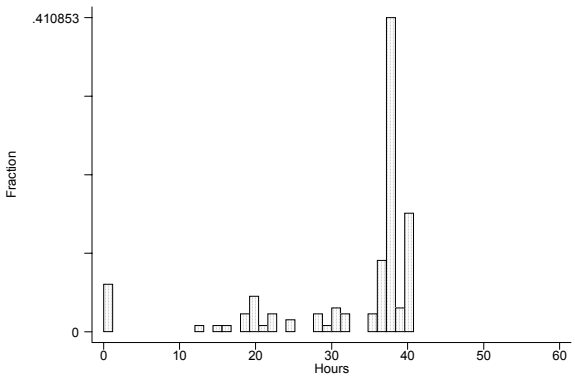

Figure 3: Contractual working hours per week for single women

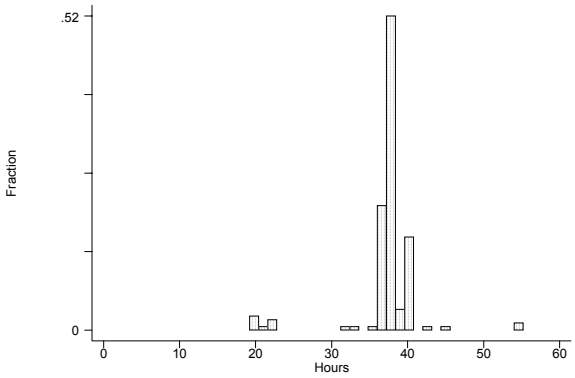

Figure 4: Contractual working hours per week for single men

ing whether they are satisfied for all observations in the sample.[8] Contrary to the above collective restrictions, results are not quite satisfactory. Monotonicity with respect to consumption is not satisfied for the 38 hours choice. For 74% of the checked labour supply choices, the marginal utility of labour is positive. The concavity restriction is not satisfied for 94% of the checked labour supply choices.[9] Since these unitary rejections are problematic from a policy evaluation point of view, we re-estimated the model with monotonicity with respect to consumption and the collective restrictions imposed.[10] The estimation results are reported in the third column of Table 3. Quite interestingly, the number of correctly predicted labour supply choices increased rather dramatically. Moreover, the imposed restrictions cannot be rejected by means of a likelihood ratio test; the test statistic of 6.99 is lower than the critical value $\chi^2_{0.05}(3) = 7.82$.

By means of the estimated coefficients and equations (14) and (15), we can derive the sharing rule parameters κ_1 and κ_2. These are respectively equal to -0.82341 and 0.00047 with corresponding standard errors of respectively 0.14595 and 0.00010. This implies the following sharing rule for the j'th hours choice of individual i (see equation (11)):

$$\phi(x_{ij}, z_i) = (0.17659 + 0.00047 \cdot z_i) \cdot x_{ij}. \tag{16}$$

The share of total household consumption that is shifted to the woman in a couple is thus positively, and significantly, related to her earning capacity. By means of this sharing rule, we can estimate the private consumption going to the woman, given her earning capacity and total household consumption (see next section).

5 Policy simulations

In this section, we focus on both a positive and normative analysis of the Belgian 2001 Tax Reform Act. As has already been mentioned, a main advantage of the collective approach is that it is able to identify gainers and losers of the tax reform at the individual level, rather than at the household level. In other words, intrahousehold distributional issues can be considered. We simulated the tax reform by calculating the pre and post reform hours choices that are most likely given the estimated model parameters and the household's budget set (i.e., net incomes for all four hours choices) for all single women and women in couples. In general, two types of behavioural responses to the tax reform will

[8] The restrictions were tested for all four labour supply choices, taking into account the corresponding consumption levels, for each observation (both singles and women in couples). This amounts to checking the restrictions for $4 \times 468 = 1872$ labour supply choices. Strictly speaking, restrictions that involve the consumption level c^f (notably, the monotonicity restriction with respect to labour supply and the quasi-concavity restriction) should be satisfied for *all* nonnegative consumption levels.

[9] The model was also applied to the subsample of single women (to which the unitary approach should be fully applicable). Monotonicity with respect to consumption was rejected for the 38 hours labour supply choice. Monotonicity with respect to labour was rejected for 25% of the checked labour supply choices. Concavity was rejected in 87% of the cases.

[10] Monotonicity with respect to consumption is imposed by means of the linear restriction $\beta_c = -\beta_{c\ell} \cdot 38$. This implies that the collective restrictions can be imposed by the restrictions $\beta^*_{c1} = -\beta^*_{c\ell 1} \cdot 38$ and $\beta^*_{c2} = -\beta^*_{c\ell 2} \cdot 38$ (cf. supra). Note that monotonicity with respect to labour supply and quasi-concavity cannot be imposed without losing the flexibility of the behavioural model.

Table 3: Parameter estimates of the female labour supply model

Variable	Unrestricted est.	Restricted est.
$\left(\ell^f\right)^2$	17.694 (3.106)	19.314 (3.116)
$\sigma_{v_{\ell\ell}}$	0.263 (0.739)	0.107 (0.469)
$\left(\ell^f\right)^2 \times$ education dummy 1	2.324 (1.362)	2.045 (1.353)
$\left(\ell^f\right)^2 \times$ education dummy 2	0.084 (1.667)	0.123 (1.637)
$\left(\ell^f\right)^2 \times$ education dummy 3	4.573 (3.310)	4.174 (2.879)
$\left(\ell^f\right)^2 \times$ region dummy 1	0.733 (1.071)	0.918 (1.071)
$\left(\ell^f\right)^2 \times$ region dummy 2	-0.407 (1.881)	-0.409 (1.859)
$\left(\ell^f\right)^2 \times$ dummy couple	-11.937 (3.021)	-12.591 (3.041)
$\left(x \times \ell^f\right)$	-2.759 (0.489)	-3.114 (0.480)
$\left(x \times \ell^f\right) \times$ dummy couple	1.917 (0.550)	2.564 (0.494)
$\left(x \times \ell^f\right) \times$ dummy couple $\times$ earning capacity	$-5.58\times10^{-7}(7.94\times10^{-7})$	$-1.46\times10^{-6}(2.59\times10^{-7})$
c^f	91.099 (22.523)	118.332 (18.252)
$x\times$ dummy couple	-105.679 (33.190)	-97.436 (18.775)
$x\times$ dummy couple $\times$ earning capacity	0.073 (0.063)	$0.056\ (9.82\times10^{-6})$
ℓ^f	-246.156 (92.383)	-330.379 (77.873)
σ_{v_ℓ}	3.523 (16.729)	2.450 (14.346)
$\ell^f\times$ education dummy 1	-43.392 (50.534)	-35.655 (50.407)
$\ell^f \times$ education dummy 2	161.965 (76.989)	147.019 (75.105)
$\ell^f \times$ education dummy 3	55.825 (179.637)	74.064 (153.146)
$\ell^f\times$ region dummy 1	-20.215 (45.373)	-26.916 (44.969)
$\ell^f\times$ region dummy 2	51.272 (87.693)	50.672 (86.265)
$\ell^f\times$ dummy couple	632.225 (174.151)	438.164 (79.691)
Log likelihood	-288.026	-291.522
Correctly predicted observations	64%	79%

Notes: All parameter estimates and standard errors (between brackets) are multiplied by 1000. Education dummy 1: 1 = secondary schooling (primary schooling benchmark). Education dummy 2: 1 = non academic higher education. Education dummy 3: 1 = academic higher education. Region dummy 1: 1 = Walloon Region (Flemish Region benchmark). Region dummy 2: 1 = Brussels Capital Region. Dummy couple: 1 = couple (single woman is benchmark). Earning capacity is the difference between the household's disposable income when the female is working full time and when she does not participate. Prediction of the labour supply for an observation is obtained by selecting the hours choice with the highest probability.

come into play. The first effect is due to the fact that the tax reform implies an expansion of all household budget sets. In other words, for each labour supply choice, a higher net income is obtained after the tax reform. The impact of the reform on the individuals' labour supply and consumption will depend on the standard interaction between income and substitution effects. This is not the end of the story, however, since the reform may also imply a change of the bargaining position of the individuals in couples, which is captured by the sharing rule. This alteration entails an impact on both the magnitude and the allocation of total household consumption to the household members. It implies an extra behavioural effect on top of the standard effects that are incorporated in the unitary approach.

Tables 4 and 5 give some summary statistics based on the pre and post reform simulations for respectively couples and single females. There are negative behavioural responses to the tax reform: average labour supply is decreased by about 6.32% for women in couples and by about 2.05% for single women after implementation of the tax reform. Although this implies a decrease of gross earnings, the private consumption of males and females in couples is increased after the reform. The percentage increase of the women's consumption, however, is on average greater than the males', since the average bargaining power of women (as measured by $(1 + \kappa_1 + \kappa_2 z_i)$; cf. supra) is slightly increased after the reform. This share, however, is not increased for all women, since some women's earning capacity is lowered after the reform. This is clearly seen in Figure 5, where quite some observations are below the diagonal. Note that the earning capacity is the result of a fairly complex interaction between the male's and female's earnings and the tax system. It is also striking that the average individual consumption of women (both before and after the reform) is much lower than that of males and single women. This lower consumption is compensated to some extent since women in couples work, on average, 7 hours less per week than their single counterparts. Going somewhat further than a pure positive description of the aggregate impact of the reform, under strong measurability and interpersonal comparability assumptions the utility of women is increased on average. This is the case both for singles and women in couples.

Table 4: Summary statistics couples pre reform versus post reform situation

	Pre reform	Post reform
Mean labour supply women	27.50	25.77
Mean gross earnings couple	889.13	871.00
Mean income tax	354.35	324.10
Mean income tax rate	0.399	0.372
Mean individual consumption women	168.87	172.71
Mean individual consumption men	409.62	417.90
Mean utility women	17.80	18.05
Mean consumption share women	0.2919	0.2924

Note: Monetary values are in euro per week, labour supply is in hours per week.

In Tables 6 and 7, simulated labour supply responses to the tax reform are shown for women in couples and single females. As is clear from the tables,

Table 5: Summary statistics single women pre reform versus post reform situation

	Pre reform	Post reform
Mean labour supply	34.18	33.48
Mean gross earnings	449.54	438.78
Mean income tax	168.28	155.11
Mean income tax rate	0.374	0.354
Mean individual consumption	334.21	336.62
Mean utility women	20.15	20.21

Note: Monetary values are in euro per week, labour supply is in hours per week.

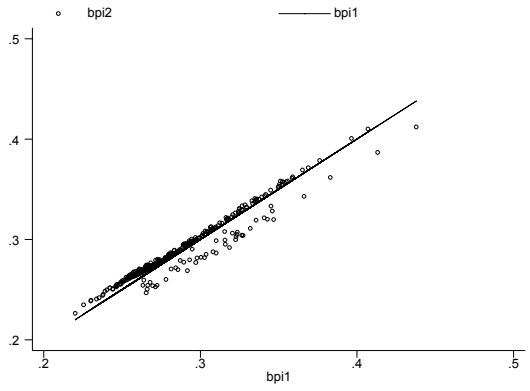

Figure 5: Pre and post reform bargaining power women (pre reform: bpi1; post reform: bpi2)

responses are rather moderate. Most of the women in couples remain on the status quo position (i.e., 94.7% are on the diagonal in Table 6). Women who change their labour supply were mainly working full time before the tax reform. Thirteen of these women opt for leaving the labour market after the reform. The impact of the reform on the singles' labour supply is also not very pronounced. The percentage of singles that do not change their labour supply equals 93.8%. Contrary to women in couples, no single woman leaves the labour market after the reform.

Table 6: Pre reform versus post reform labour supply women in couples

	0	20	30	38	Total
0	92	0	0	0	92
20	1	5	0	0	6
30	0	0	1	0	1
38	13	2	2	224	241
Total	106	7	3	224	340

Note: Rows are pre reform labour supply, columns post reform.

Table 7: Pre reform versus post reform labour supply single women

	0	20	30	38	Total
0	10	0	0	0	10
20	0	7	0	0	7
30	0	4	7	0	11
38	0	3	1	96	100
Total	10	14	8	96	128

Note: Rows are pre reform labour supply, columns post reform.

Table 8 shows the numbers of gainers and losers of the tax reform for individuals in couples and singles. As is clear from the table, the tax reform implies a Pareto improvement for the majority of the couples: both individuals' utility levels are increased after the reform.[11] For 18 couples, the woman's welfare is increased, while the man's welfare is decreased by the reform. In 29 cases, the male is better off after the reform, while the female is worse off. There are no households where both members are worse off after the reform. Note that this kind of results at the individual level is impossible when modelling household labour supply behaviour by means of a unitary model. Given the expansion of the budget sets by the tax reform, it is hardly surprising that the majority of the singles strictly gain from the reform.

Table 9 provides an inequality analysis with respect to private consumption on an individualistic basis over both single females and individuals in couples. The inequality measures used in this analysis belong to the generalized entropy

[11] The male's utility level is represented by his individual consumption.

Table 8: Gainers and losers of the tax reform

	f(-)	f(0)	f(+)
m(-)	0	0	18
m(0)	0	0	0
m(+)	29	35	258
	s(-)	s(0)	s(+)
	0	39	89

Note: The variables m, f and s refer to respectively the utility level of males and females in couples, and the single females' utility level. The labels (-),(0) and (+) refer to a decrease, a status quo or an increase in the corresponding utility level.

class. These measures are defined as follows (see Foster and Sen, 1997):

$$I_\alpha(\mathbf{c}) = \frac{1}{\alpha(1-\alpha)}\frac{1}{n}\sum_{i=1}^{n}\left[1-\left(\frac{c_i}{\mu}\right)^\alpha\right],\ \alpha \notin \{0,1\}, \tag{17}$$

where n is the number of individuals in the analysis, c_i individual i's private consumption, $\mathbf{c}$ an n-vector of private consumption levels, μ the average private consumption and α an inequality aversion parameter. If α equals 1 or 0, we respectively have Theil's entropy measure and Theil's second inequality measure or mean logarithmic deviation:

$$I_1(\mathbf{c}) = \frac{1}{n}\sum_{i=1}^{n}\frac{c_i}{\mu}\ln\left(\frac{c_i}{\mu}\right) \tag{18}$$

$$I_0(\mathbf{c}) = \frac{1}{n}\sum_{i=1}^{n}\ln\left(\frac{\mu}{c_i}\right). \tag{19}$$

Parameter α indicates the sensitivity of the associated inequality measure to transfers at different parts of the distribution. It can be shown that all measures with $\alpha < 2$ favour transfers at the lower end of the distribution. A main characteristic of the inequality measures in the generalized entropy class is that they can be additively decomposed. In other words, these measures allow to disentangle total inequality over individuals belonging to several groups into inequality between these groups and inequality among the individuals in the different groups. More specifically, the following can be shown for our three groups case (single females is group S, females in couples is group F and males in couples is group M):

$$I_\alpha(\mathbf{c}) = w_S I_\alpha(\mathbf{c}_S) + w_F I_\alpha(\mathbf{c}_F) + w_M I_\alpha(\mathbf{c}_M) + I_\alpha(\overline{\mathbf{c}}_S, \overline{\mathbf{c}}_F, \overline{\mathbf{c}}_M), \tag{20}$$

where $w_I = \frac{n_I}{n}\left(\frac{\mu_I}{\mu}\right)^\alpha$ is the weight of group I in the analysis, n_I the number of individuals in I, μ_I the mean consumption of these individuals, $\mathbf{c}_I$ the vector of private consumption levels of the individuals belonging to group I and $\overline{\mathbf{c}}_I$ is an n_I-vector where each element equals μ_I.

In the table below, inequality measures are given for α equal to -1, 0 and 1. All three inequality measures indicate that overall inequality decreased after the tax reform. This decrease is partly due to the decrease of the between group inequality $I_\alpha(\overline{\mathbf{c}}_S, \overline{\mathbf{c}}_F, \overline{\mathbf{c}}_M)$. In addition, the inequality among single females $I_\alpha(\mathbf{c}_S)$, among females in couples $I_\alpha(\mathbf{c}_F)$ and among men in couples $I_\alpha(\mathbf{c}_M)$ is decreased after the tax reform.

Table 9: Inequality analysis pre and post reform situation

	$\alpha=-1$		$\alpha=0$		$\alpha=1$	
	Pre	Post	Pre	Post	Pre	Post
$I_\alpha(\mathbf{c})$	110.48	106.67	94.12	91.55	84.91	82.97
$I_\alpha(\overline{\mathbf{c}}_S, \overline{\mathbf{c}}_F, \overline{\mathbf{c}}_M)$	86.31	85.22	76.04	75.31	69.26	68.80
$I_\alpha(\mathbf{c}_S)$	28.28	26.09	25.32	23.17	23.51	21.40
w_S	196.60	198.62	219.66	219.66	245.43	242.93
$I_\alpha(\mathbf{c}_F)$	23.29	20.29	23.45	20.55	24.18	21.24
w_F	691.11	687.64	390.17	390.17	220.27	221.38
$I_\alpha(\mathbf{c}_M)$	8.80	8.13	8.64	8.03	8.54	7.98
w_M	284.92	284.18	390.17	390.17	534.30	535.69

Note: All figures are multiplied by 1000.

In the above inequality analysis, we focused on the distribution of the cake, rather than on the size. However, we can also compare the pre and post reform distributions of individual consumption by means of social evaluation functions, which are functions of both mean consumption and an appropriate inequality index (see, e.g., Lambert, 2001). Here, we focus on a social evaluation function that is based on Theil's normalized entropy measure:

$$W = \mu\left(1 - I_1^*(\mathbf{c})\right), \tag{21}$$

where $I_1^*(\mathbf{c}) = \frac{I_1(\mathbf{c})}{\ln n}$. Both an increase in mean consumption and a decrease in inequality positively affect social welfare W. If we apply (21) to the pre and post reform consumption distributions, we obtain a social welfare of respectively 295.37 and 300.65. Consequently, the tax reform seems to have a positive impact on social welfare.[12]

6 Conclusion

In this paper, a new methodology is presented to estimate a discrete choice model for female labour supply. The model is cast in the collective setting and is fairly general in that it allows for both nonparticipation and nonlinear taxation. Identification of the model is obtained by assuming that some, but not all, preference parameters of single women and females in couples are identical; marginal rates of substitution between consumption and leisure may well differ. By means of this, not very restrictive, assumption, both females' preferences and

[12]Note that the government revenue is decreased rather substantially by the tax reform. The analysis of the implications of this decrease on the provision of public goods and the consequent impact on the individuals' welfare go beyond the scope of this paper.

the rule governing the sharing of total household consumption, as a function of the earning capacity of the female, are econometrically identifiable. This feature is rather important, since it allows to take into consideration intrahousehold distributional issues, on top of standard interhousehold ones.

The model is applied to Belgian microdata and is used to evaluate the 2001 Tax Reform Act. This tax reform incorporates some important changes of the pre reform tax system. Two types of theoretical restrictions are implied by the specific model we use. A first restriction is linked to the collective setting and is not rejected by the data. The model also implies some standard unitary restrictions on the identified female preferences. The latter restrictions, however, are rejected when confronted with the data. As to the sharing rule, the earning capacity of females seems to have a significantly estimated positive impact on the share in total household consumption that is shifted to the woman.

The impact of the tax reform on hours and participation is moderate, with a reduction of about -6.32% of aggregate labour supply of females in couples and -2.05% for single women. Further, the tax reform implies a strict Pareto improvement for 76% of the couples in the sample. For most of the other households, the tax reform is beneficial to one of the household members, while the other is worse off. Note that such results, which refer to the intrahousehold allocation of welfare, cannot be obtained in the standard unitary approach to household labour supply.

Although the obtained results are not entirely satisfactory due to the rejection of some behavioural restrictions, the approach shows its relevance in analysing changes in fiscal policy. The study has its limitations however. To increase its empirical relevance, the model should be generalized so that it can adequately deal with external effects and the presence of children in the household. In order to retain an econometrically identifiable model, preferences will probably need to be restricted in one way or another (e.g., Beckerian caring preferences, see Chiappori, 1988, 1992). A second limitation of the study at hand is that it does not take into account elements of household public consumption. A large share of total household means, however, is spent on goods with a public consumption component, such as rent or heating. Two recent studies that deal with household public consumption in a different way are Lewbel, Chiappori and Browning (2001) and Chiappori, Blundell and Meghir (2002). Finally, the model does not incorporate household production (see Apps and Rees, 1997 and Chiappori, 1997). The simple dichotomy between market time and leisure may be an inadequate assumption in modelling household labour supply. The increasing availability of time budget studies may enhance the empirical modelling of household labour supply incorporating household production.

References

[1] Apps, P. and R. Rees (1988), "Taxation and the household", *Journal of Public Economics*, 35, 355-369.

[2] Apps, P. and R. Rees (1997), "Collective labour supply and household production", *Journal of Political Economy*, 105, 178-190.

[3] Barmby, T. and N. Smith (2001), "Household labour supply in Britain and Denmark: some interpretations using a model of Pareto optimal behaviour", *Applied Economics*, 33, 1109-1116.

[4] Bingley, P. and I. Walker (1997), "The labour supply, unemployment and participation of lone mothers in in-work transfer programs", *Economic Journal*, 107, 1375-1390.

[5] Blundell, R., P.-A. Chiappori, T. Magnac and C. Meghir (2001), "Collective labor supply: heterogeneity and nonparticipation", Mimeo, London, Institute for Fiscal Studies.

[6] Blundell, R., A. Duncan, J. McCrae and C. Meghir (1999), "Evaluating in-work benefit reform: the Working Families Tax Credit in the UK", Mimeo, London, Institute for Fiscal Studies.

[7] Brett, C. (1998), "Tax reform and collective family decision-making", *Journal of Public Economics*, 70, 425-440.

[8] Browning, M. and P.-A. Chiappori (1998), "Efficient intra-household allocations: a general characterization and empirical tests", *Econometrica*, 66, 1241-1278.

[9] Chiappori, P.-A. (1988), "Rational household labor supply", *Econometrica*, 56, 63-90.

[10] Chiappori, P.-A. (1992), "Collective labor supply and welfare", *Journal of Political Economy*, 100, 437-467.

[11] Chiappori, P.-A. (1997), "Introducing household production in collective models of labor supply", *Journal of Political Economy*, 105, 191-209.

[12] Chiappori, P.-A., B. Fortin and G. Lacroix (2002), "Marriage market, divorce legislation and household labor supply", *Journal of Political Economy*, 110, 37-72.

[13] Donni, O. (2001), "Collective household labor supply: non-participation and income taxation", forthcoming in *Journal of Public Economics*.

[14] Fortin, B. and G. Lacroix (1997), "A test of the unitary and collective models of household labour supply", *Economic Journal*, 107, 933-955.

[15] Foster, J. and A. Sen (1997), "On economic inequality after a quarter century" in A. Sen (editor), *On Economic Inequality*, Oxford, Clarendon Press, 107-219.

[16] Gong, X. and A. van Soest (2002), "Family structure and female labor supply in Mexico City", *Journal of Human Resources*, 37, 163-191.

[17] Hoynes, H. (1996), "Welfare transfers in two-parent families: labor supply and welfare participation under AFDC-UP", *Econometrica*, 64, 295-332.

[18] Keane, M. and R. Moffitt (1998), "A structural model of multiple welfare program participation and labor supply", *International Economic Review*, 39, 553-589.

[19] Laisney, F. (2002) (editor), *Welfare analysis of fiscal and social security reforms in Europe: does the representation of family decision processes matter?*, Final report on EU-project VS/2000/0778, Mannheim, Zentrum für Europäische Wirtschaftsforschung.

[20] Lambert, P. (2001), *The Distribution and Redistribution of Income*, Manchester, Manchester University Press.

[21] Lewbel, A., P.-A. Chiappori and M. Browning (2001), "Estimating consumption economies of scale, adult equivalence scales, and household bargaining power", Mimeo, Chestnut Hill, Boston College.

[22] McFadden, D. (1974), "Conditional logit analysis of qualitative choice behavior" in P. Zarembka (editor), *Frontiers in Econometrics*, New York, Academic Press, 105-142.

[23] Moreau, N. and O. Donni (2002), "Estimation d'un modèle collectif d'offre de travail avec taxation", *Annales d'Economie et de Statistique*, 65, 55-84.

[24] Pencavel, J. (1986), "Labor supply of men: a survey" in O. Ashenfelter and R. Layard (editors), *Handbook of Labor Economics, Volume 1*, Amsterdam, Elsevier, 3-102.

[25] Reynders, D. (2000), *Personenbelasting. Ontwerp van Fiscale Hervorming (Personal Income Tax. Design of the Fiscal Reform)*, Brussels, Ministry of Finance.

[26] Stern, N. (1986), "On the specification of labour supply functions" in R. Blundell and I. Walker (editors), *Unemployment, Search and Labour Supply*, Cambridge, Cambridge University Press, 143-189.

[27] Train, K. (1998), "Recreation demand models with taste differences over people", *Land Economics*, 74, 230-239.

[28] van Soest, A. (1995), "Structural models of family labor supply. A discrete choice approach", *Journal of Human Resources*, 30, 63-88.

[29] Vermeulen, F. (2002a), "Collective household models: principles and main results", *Journal of Economic Surveys*, 16, 533-564.

[30] Vermeulen, F. (2002b), "Where does the unitary model go wrong? Simulating tax reforms by means of unitary and collective labour supply models. The case for Belgium", in F. Laisney (editor), *Welfare analysis of fiscal and social security reforms in Europe: does the representation of family decision processes matter?*, Final report on EU-project VS/2000/0778, Mannheim, Zentrum für Europäische Wirtschaftsforschung.